Preliminary Survival Estimates for Juvenile Chinook Salmon Passing the Bonneville Spillway in 2007

Sponsor: USACE District, Portland

Oversight: Dennis Schwartz

Collaboration: PNNL / Battelle

Ploskey, Weiland, Hughes, Zimmerman, Durham, Fulton, Tunnicliff, Hearsey, Vucelick

Skalski Statistical Services

Skalski and Townsend

NOAA Fisheries

McComas, Everett, Brege, Mosher, Wolf, Gilbreath,

Pacific States Fisheries Commission

Fischer, Kim, Charlton, Leighton, Guest, McComas, Ballinger

Cascade Aquatics

Prather, Ilgenfritz, James

Objectives

- Estimate survival of yearling Chinook salmon in spring and sub-yearlings in summer
  - Bonneville spillway forebay releases = treatments
    (total and by spill-bay type)
  - Tailrace releases provided reference estimates
- Test whether survival of fish passing through bays with deep deflectors was higher than that of fish passing through bays with shallow spill deflectors
  - End bays 1-3 and 16-18 have deflectors at 7-ft above mean sea level (MSL)
  - Middle bays 4-15 have deflectors at 14-ft above MSL
  - Historical data suggest that survival was higher for fish passing end bays than for fish passing mid bays, and it may depend on tailwater elevation

Detection Arrays - Bonneville Spillway

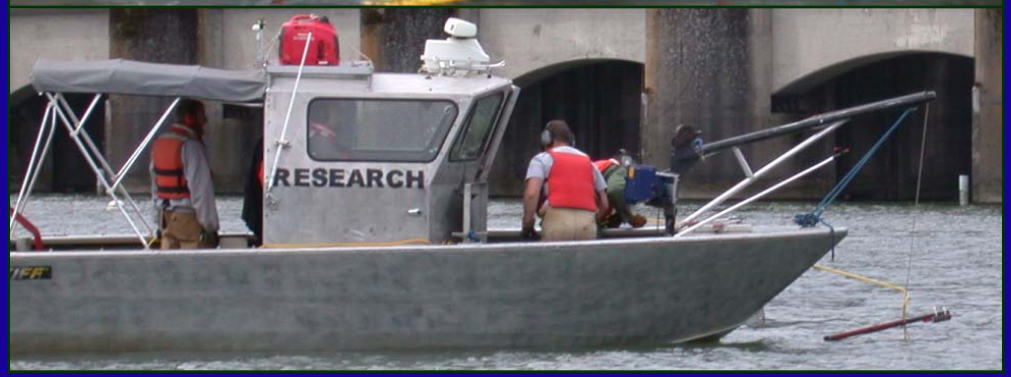
- Deployed 16 hydrophones on trolleys in pipes
- Initially un-baffled and then finally baffled

Top View

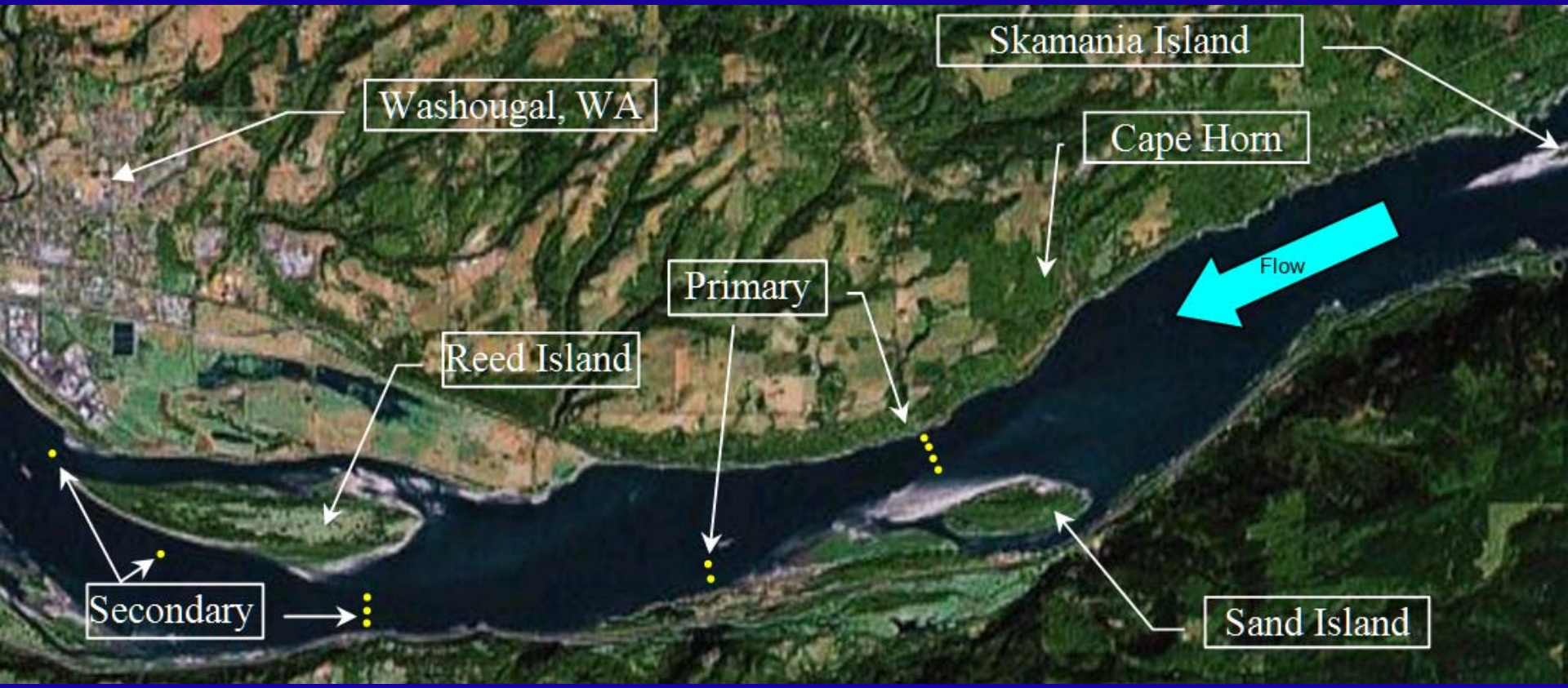
Side View

Bonneville Spillway

- Deployed 5 star clusters about 150 ft upstream of the spillway



Survival Arrays – Primary & Secondary

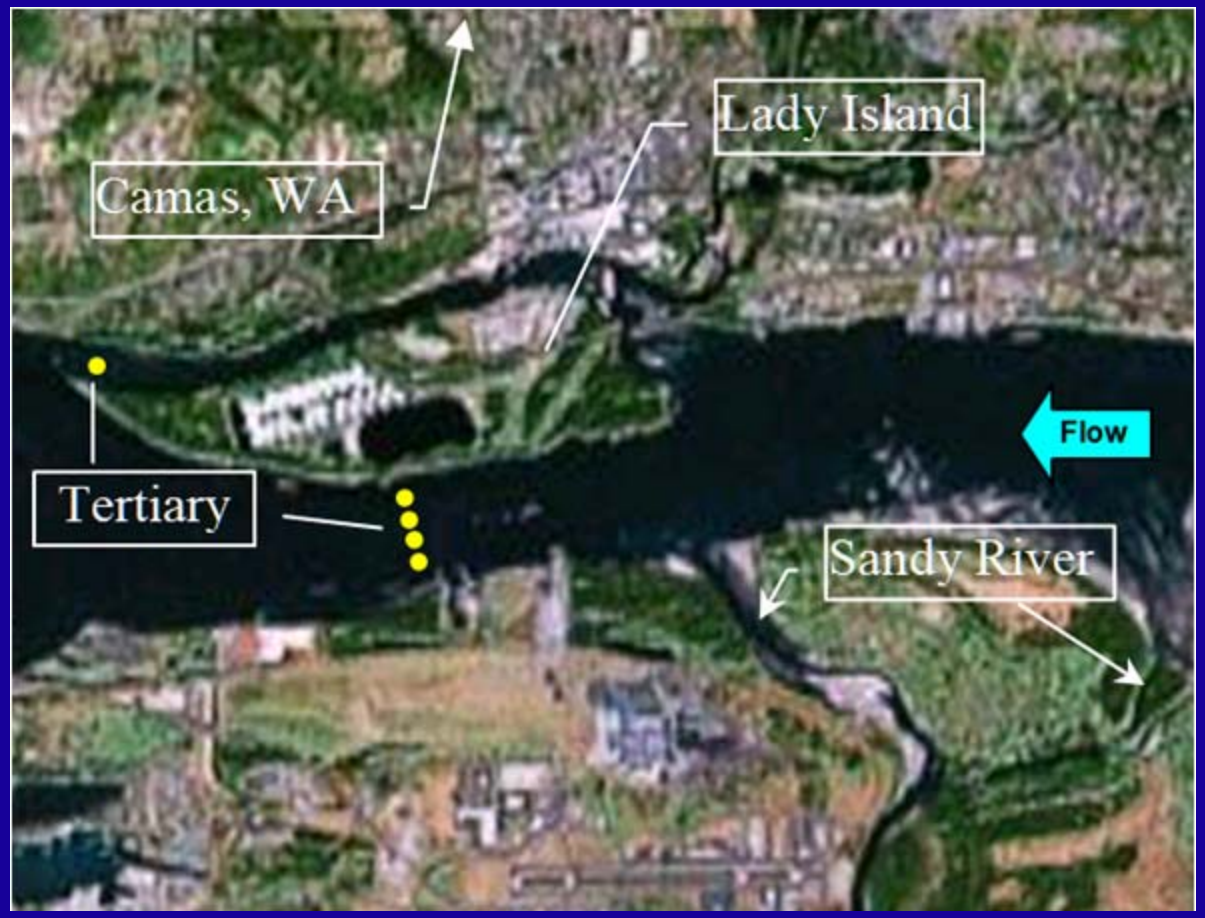


30.4 km

3.5 km

25.6 km – km downstream

Survival Arrays - Tertiary



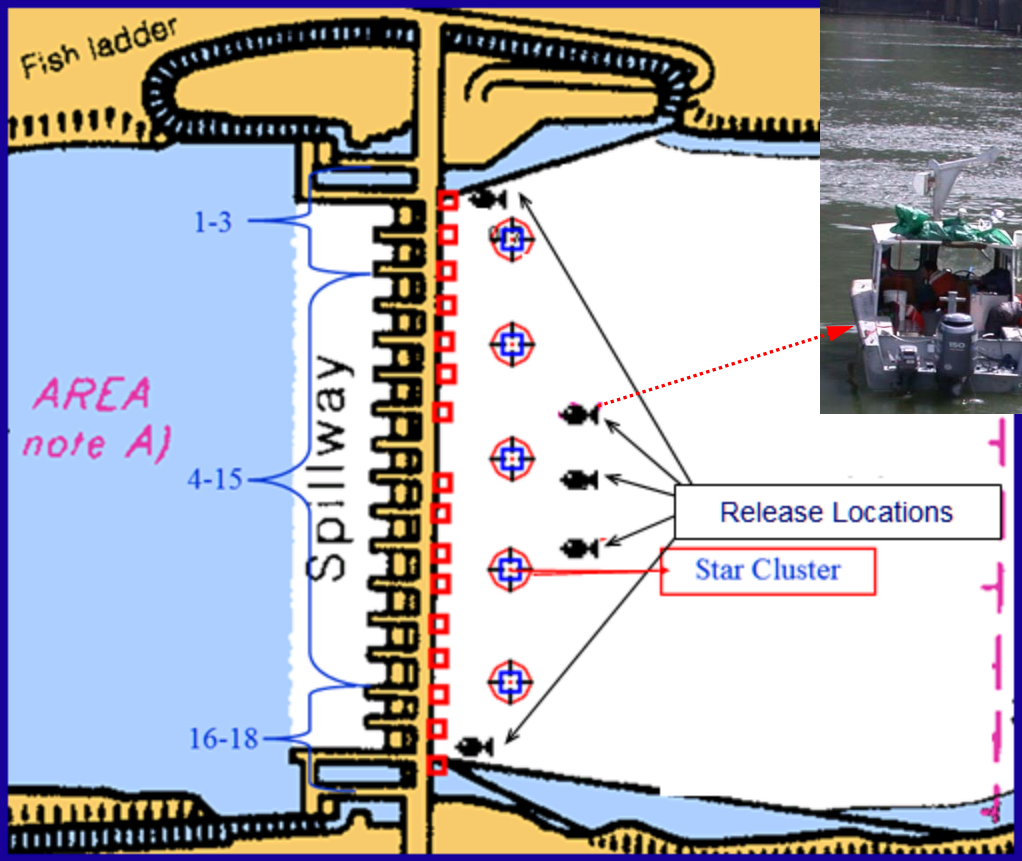
42.4 km – downstream

Tagging and Release of Fish

- 4,037 Yearling Chinook salmon in spring
  4,038 Subyearling Chinook salmon in summer
  - 252-288 / day were collected at BON SMF
    - 188-212 for spillway forebay and about 65 for the tailrace
  - Held overnight
  - Surgically implanted with JSATS tags
  - Held about 26 h
  - Released gradually by boat over a 3-4 h period (1400-1800 h)
    - 16 days in spring and 14 days in summer
    - Daytime releases should provide worst-case survival estimates
    - Spillway forebay releases by PNNL were at five lateral locations
    - Tailrace reference releases by NOAA Fisheries began about 1 h after start of forebay releases and were at several lateral locations adjacent to CE ramp

Forebay releases were in specific locations to encourage passage in two types of bays:

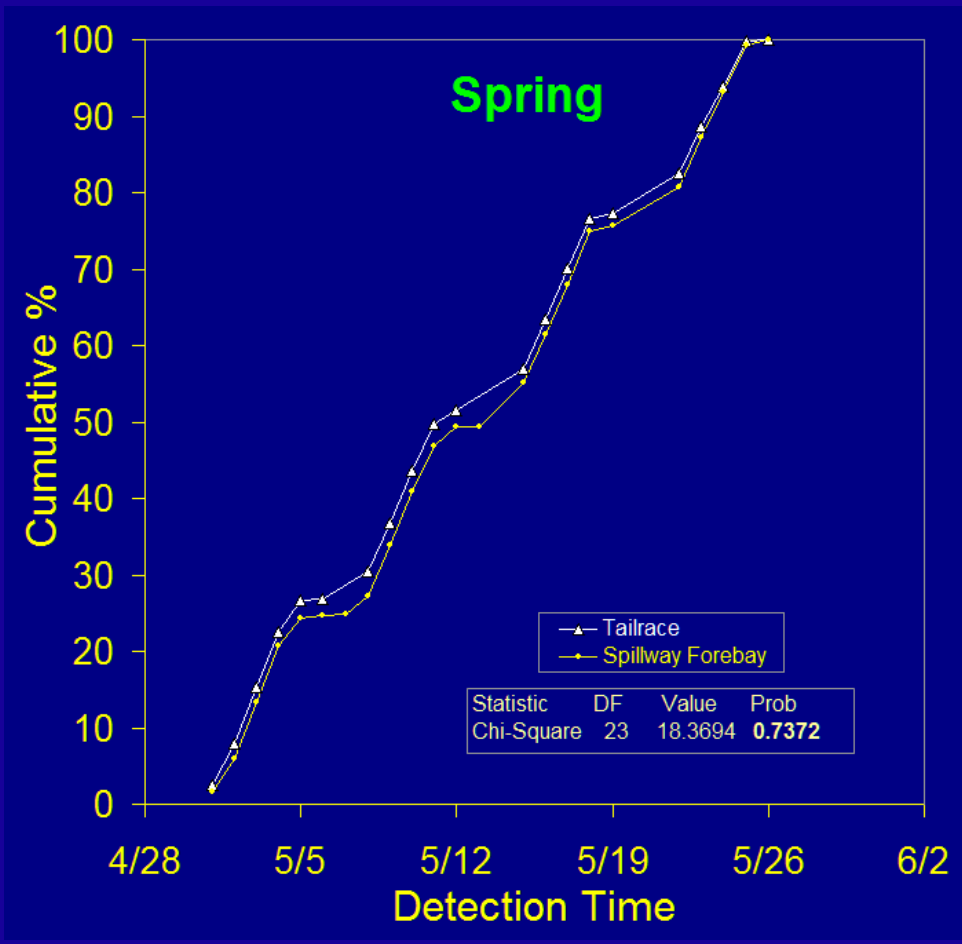
- Deep deflectors (End bays 1-3 and 16-18)
- Shallow deflectors (Mid bays 4-15)

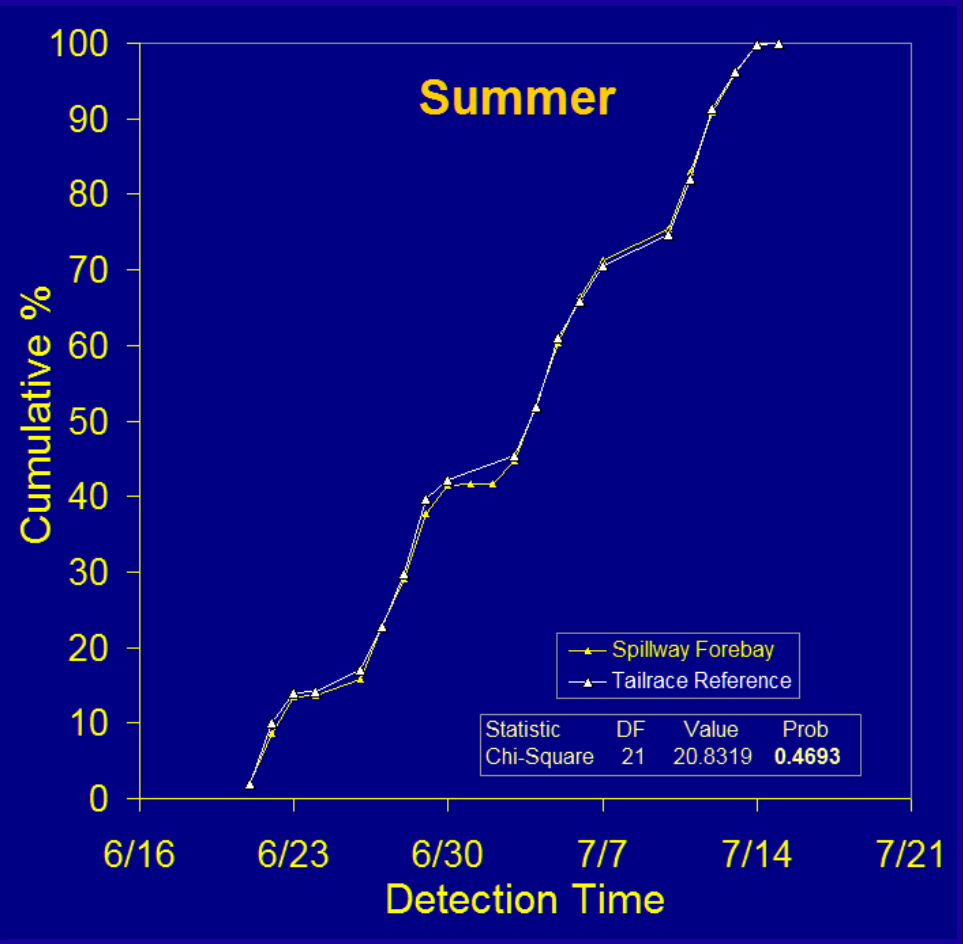


RESULTS:
Tagging Mortality and Dead Fish Releases

- Tagging / handling mortality < 0.5% each season
- Excluding intentional sacrifices to meet quotas for dead-fish releases, mortality was
  - about 0.2% in spring
  - about 0.3% in summer
- In summer, one tagged dead fish of 20 was detected on all three survival arrays
  - Detection arrays were located 25.6, 30.4, and 42.4 km downstream of the dam
  - The rate was 1 out of 40 (2.5%) for 2006 and 2007 combined

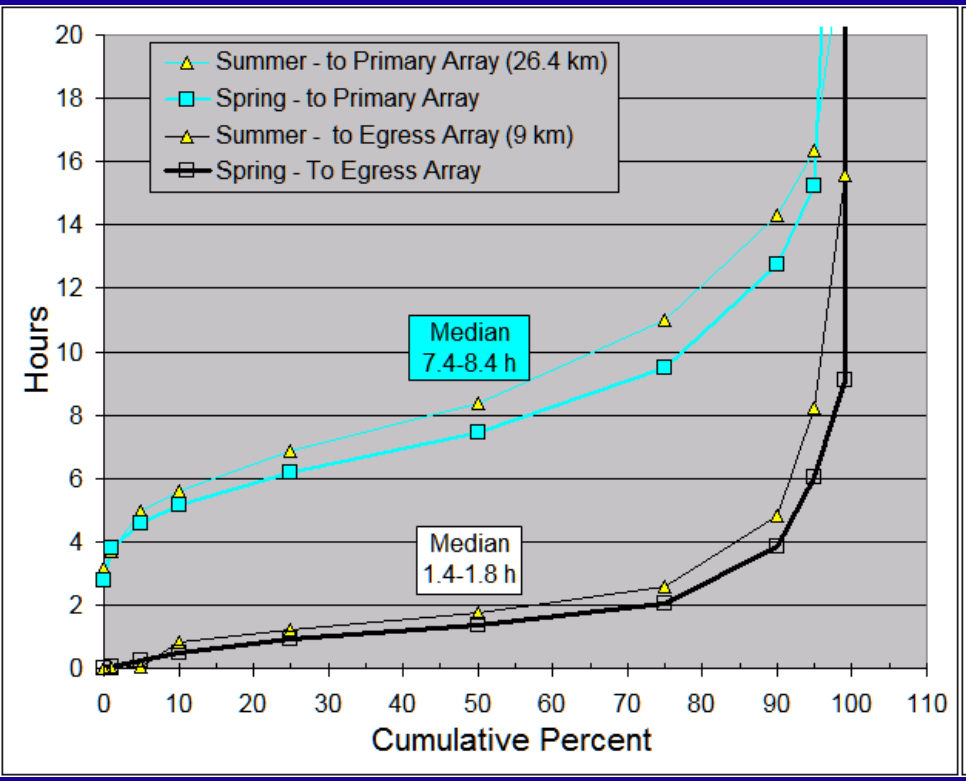
Test for Mixing of Treatment & Reference Fish based on Arrival Times at the Primary Array



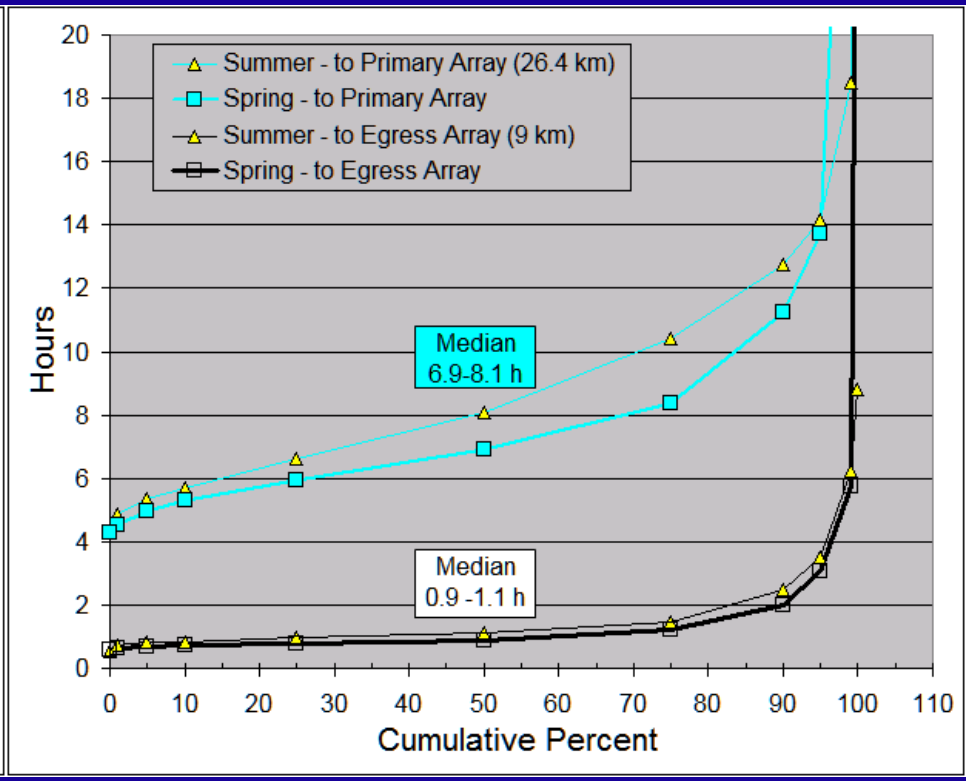


Juvenile Chinook Egress Time

Spilled

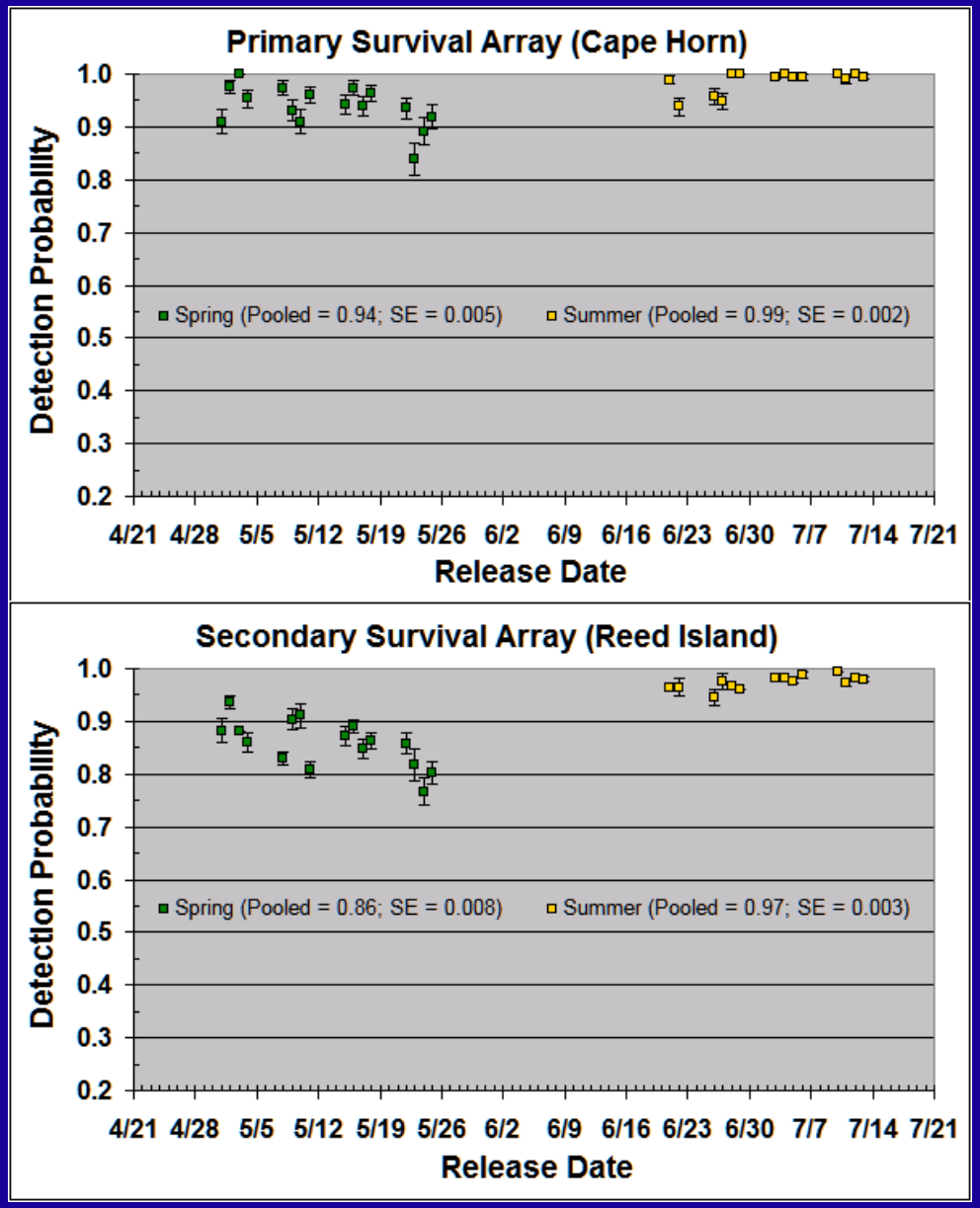


Tailrace

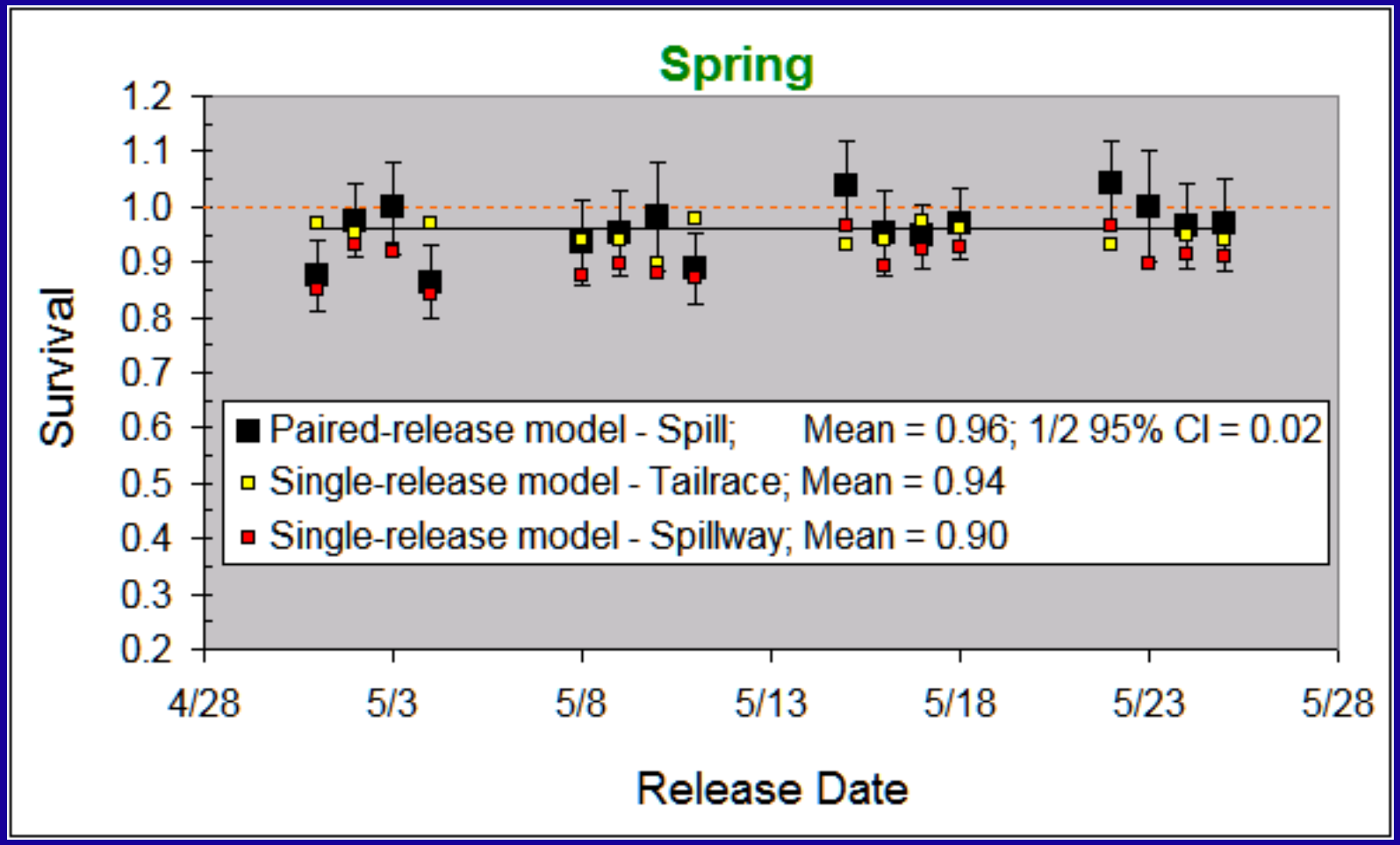


Difference: 0.5-0.7 h = median travel time to tailrace release location from the forebay

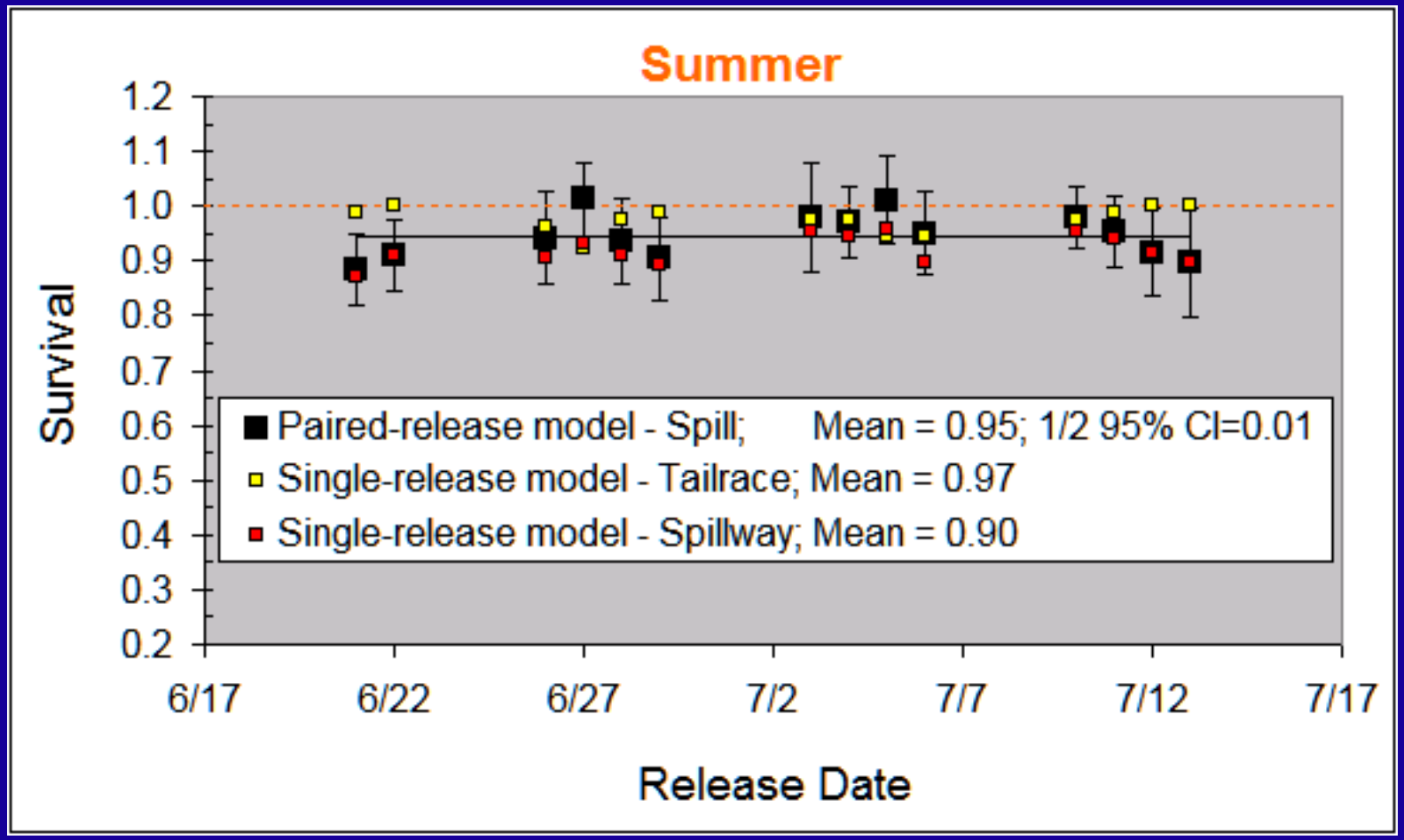
Detection Probabilities - Survival



Spillway Survival

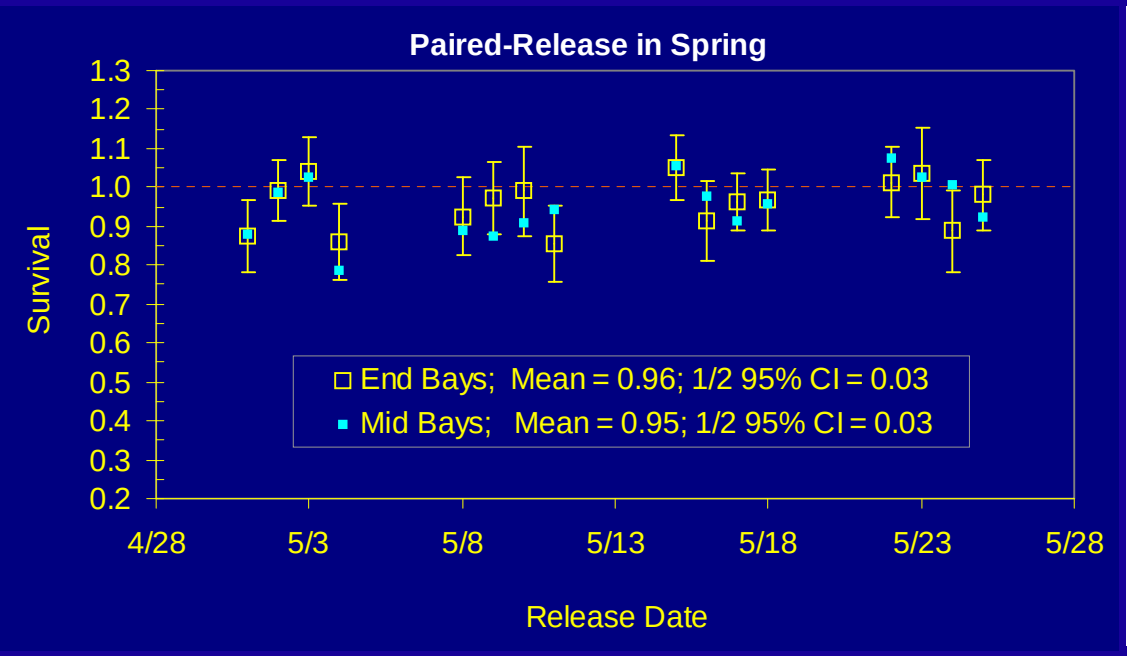


Spillway Survival



Yearling Chinook Survival

(End Bays vs. Mid Bays based on Release Location)



Test Single-release Model Differences

z-Test: Two Sample for Means

Statistics	*End S*	*Mid S*
Mean	0.902	0.897
Known Variance	0.0023	0.0043
Observations	16	16
Hypothesized Mean Diff	0	
z	0.2679	
P(Z<=z) one-tail	0.3944	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.7888	
z Critical two-tail	1.96	

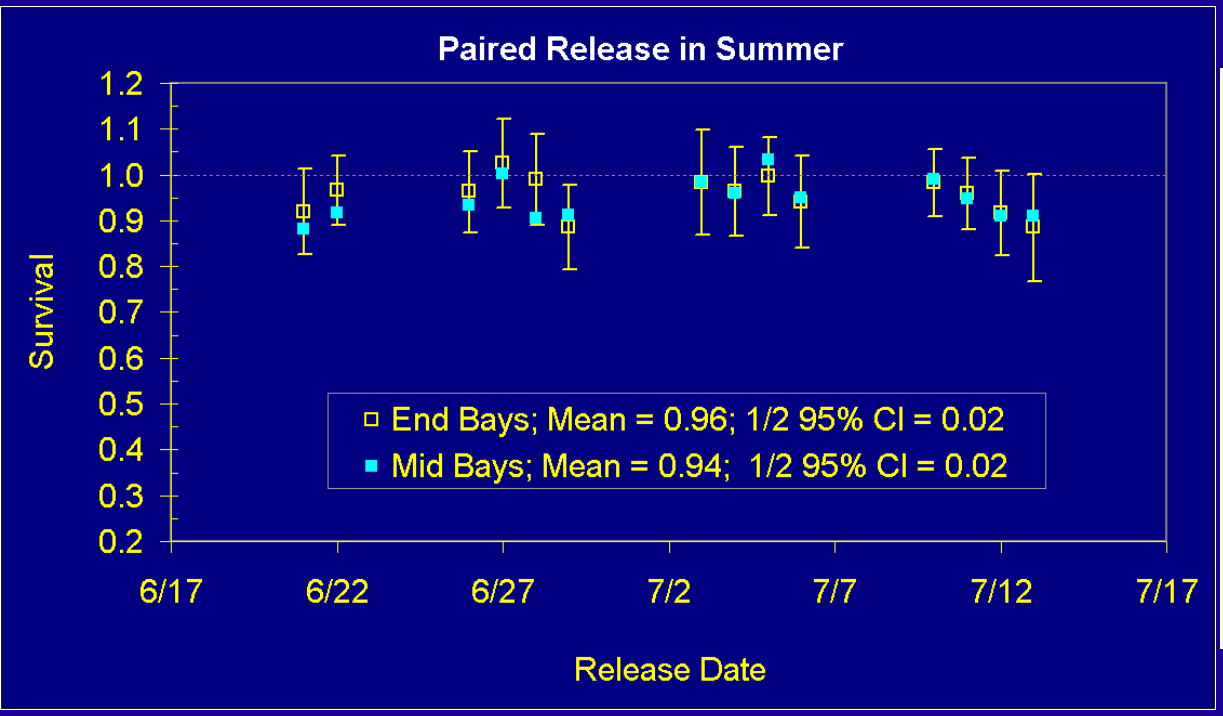
81% of fish released at end bays passed there.

64% of fish released at mid bays passed there.

*Hydrophones were un-baffled all but the last three days of spring.

Sub-yearling Chinook Survival

End Bays vs. Mid Bays in Summer by Bay of Passage



Test Single-release Model Differences

z-Test: Two Sample for Means

Statistics	*End S*	*Mid S*
Mean	0.9554	0.945
Known Variance	0.001	0.001
Observations	14	14
Hypothesized Mean Diff	0	
z	0.8672	
P(Z<=z) one-tail	0.1929	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.3858	
z Critical two-tail	1.96	

Observations / Conclusions

- All hydrophones near the spillway had to be baffled to prevent signal saturation
  - Permission to make changes after spill begins required several weeks (plan ahead for changes)
- Mixing of treatment and reference releases was very good
- Median detection probabilities (P_1 & P_2) were greatly improved over 2006
  - Median P_1 was 94.1% in spring and 98.5% in summer versus 70-80% in 2006

Observations / Conclusions

- Lack of decline in survival in late summer may be the result of releasing fresh fish directly into the forebay
- More sub-yearlings (about 57) than yearlings (2) rerouted to B2 from the spillway forebay after release
- Proportionally more yearlings than sub-yearlings passed where released
- Fish passing end bays did not have significantly higher survival than fish passing middle bays
  - Why?
    - New daytime spill patterns with higher minimum gate opening.
    - Precision was good on single- and paired-release estimates